

**7. CLAIMS**

What is claimed is:

- 1     1.     A method of inductive learning comprising:  
2             receiving training data;  
3             providing vectors having a set of parameters based  
4     on said training data; and  
5             generating a cluster database comprising clusters,  
6     said clusters being associated with respective ranges of  
7     values for at least a subset of said set of parameters.
- 1     2.     The method of claim 1 wherein said subset of said  
2     set of parameters is said set of parameters.
- 1     3.     The method of claim 1 further comprising:  
2             supplying, by a data acquisition module, said  
3     training data.
- 1     4.     The method of claim 1 wherein said training data  
2     comprises archived data.
- 1     5.     The method of claim 1 wherein said training data  
2     comprises simulated nominal data.
- 1     6.     The method of claim 1 wherein said training data  
2     comprises off-nominal data.

1     7.    The method of claim 1 further comprising:  
2            scaling said training data associated with at least  
3     one parameter of said set of parameters.

1     8.    The method of claim 1 wherein said generating  
2     comprises:  
3            determining a distance between one of said vectors  
4     and one of said clusters, and  
5            producing a new cluster if said distance exceeds a  
6     threshold value.

1     9.    The method of claim 1 wherein said generating  
2     comprises:  
3            determining a distance between one of said vectors  
4     and one of said clusters, and  
5            expanding said one of said clusters to include said  
6     vector when said distance is less than or equal to a  
7     threshold value.

1     10.   The method of claim 1 further comprising:  
2            indexing said clusters of said cluster database  
3     based on a distance of each of said clusters from a  
4     predetermined indexing reference point, and  
5            organizing said clusters into a data structure based  
6     on said indexing.

1     11.   A method of monitoring a system comprising:  
2            providing a cluster database comprising clusters,  
3     said clusters being associated with respective ranges of

4 values for at least a subset of a set of cluster  
5 parameters;

6 receiving one or more monitored-system vectors  
7 having monitored-system parameters; and

8 determining whether said monitored-system vector is  
9 contained in one of said clusters based on at least a  
10 subset of said monitored-system parameters and said at  
11 least a subset of said cluster parameters.

1 12. The method of claim 11 further comprising:

2 if one of said monitored-system vectors is not  
3 contained in one of said clusters, determining a distance  
4 of said one monitored-system vector from a nearest of  
5 said clusters, wherein said distance is associated with a  
6 severity of a deviation.

1 13. The method of claim 12 wherein said determined  
2 distance provides a comparison result for each monitored-  
3 system vector, further comprising:

4 supplying said monitored-system vectors and said  
5 comparison result associated therewith to another  
6 learning application.

1 14. The method of claim 11, further comprising:

2 examining said monitored-system vectors to determine  
3 if any parameter is erroneous; and

4 if any parameter of one of said monitored-system  
5 parameters is erroneous, adjusting said erroneous  
6 parameter such that said parameter will match any range

7 specified for said parameter in any cluster of said  
8 cluster database.

1 15. The method of claim 11 further comprising:  
2 providing an additional cluster database, the  
3 clusters of said additional cluster database being  
4 associated with respective ranges of values for at least  
5 a subset of said set of parameters, said additional  
6 cluster database being annotated with diagnostic  
7 information; and  
8 if one of said monitored-system vectors is not  
9 included in one of said clusters, comparing said one of  
10 said monitored-system vectors with said clusters of said  
11 additional cluster database.

1 16. An article of manufacture comprising a computer  
2 program usable medium embodying one or more instructions  
3 executable by a computer for performing a method of  
4 inductive learning, the method comprising:  
5 receiving training data;  
6 providing vectors having a set of parameters based  
7 on said training data; and  
8 generating a cluster database comprising clusters,  
9 said clusters being associated with respective ranges of  
10 values for at least a subset of said set of parameters.

1 17. The article of manufacture of claim 16 wherein said  
2 subset of said set of parameters is said set of  
3 parameters.

1 18. The article of manufacture of claim 16, said method  
2 further comprising:  
3 supplying, by a data acquisition module, said  
4 training data.

1 19. The article of manufacture of claim 16 wherein said  
2 training data comprises archived data.

1 20. The article of manufacture of claim 16 wherein said  
2 training data comprises simulated nominal data.

1 21. The article of manufacture of claim 16 wherein said  
2 training data comprises off-nominal data.

1 22. The article of manufacture of claim 16, said method  
2 further comprising:  
3 scaling said training data associated with at least  
4 one parameter of said set of parameters.

1 23. The article of manufacture of claim 16 wherein said  
2 generating the cluster database comprises:  
3 determining a distance between one of said vectors  
4 and one of said clusters, and  
5 producing a new cluster if said distance exceeds a  
6 threshold value.

1 24. The article of manufacture of claim 16 wherein said  
2 generating a cluster database comprises:

3           determining a distance between one of said vectors  
4   and one of said clusters, and  
5           expanding said one of said clusters to include said  
6   vector when said distance is less than or equal to a  
7   threshold value.

1   25.   The article of manufacture of claim 16, wherein said  
2   method further comprises:

3           indexing said clusters of said cluster database  
4   based on a distance of each of said clusters from a  
5   predetermined reference point.

1   26.   An article of manufacture comprising a computer  
2   program usable medium embodying one or more instructions  
3   executable by a computer for performing a method of  
4   monitoring a system, the method comprising:

5           receiving one or more monitored-system vectors  
6   having monitored-system parameters; and

7           determining whether said monitored-system vector is  
8   contained in a cluster of a cluster database comprising a  
9   set of clusters, said clusters of the set being  
10   associated with respective ranges of values for at least  
11   a subset of a set of cluster parameters, said determining  
12   being based on at least a subset of said monitored-system  
13   parameters and said at least a subset of said cluster  
14   parameters.

1   27.   The article of manufacture of claim 26, wherein said  
2   method further comprises:

3           if one of said monitored-system vectors is not  
4       contained in one of said clusters, determining a distance  
5       of said one monitored-system vector from the nearest of  
6       said clusters, wherein said distance is associated with a  
7       severity of a deviation.

1       28. The article of manufacture of claim 27 wherein said  
2       determined distance provides a comparison result for each  
3       monitored-system vector, said method further comprising:  
4           supplying said monitored-system vectors and said  
5       comparison result associated therewith to another  
6       learning application.

1       29. The article of manufacture of claim 26, wherein said  
2       method further comprises:

3           if any parameter of one of said monitored-system  
4       parameters is erroneous, adjusting said erroneous  
5       parameter such that said parameter will match any range  
6       specified for said parameter in any cluster of said  
7       cluster database.

1       30. The article of manufacture of claim 26, wherein said  
2       method further comprises:

3           if one of said monitored-system vectors is not  
4       included in one of said clusters, comparing said one of  
5       said monitored-system vectors with clusters of an  
6       additional cluster database, said clusters of said  
7       additional cluster database being associated with  
8       respective ranges of values for at least a subset of said

9 set of parameters, said additional cluster database being  
10 annotated with diagnostic information.

1 31. An apparatus for inductive learning comprising:  
2 a computer; and  
3 one or more computer programs, executed by said  
4 computer, for:  
5 receiving training data;  
6 providing vectors having a set of parameters based  
7 on said training data; and  
8 generating a cluster database comprising clusters,  
9 said clusters being associated with respective ranges of  
10 values for at least a subset of said set of parameters.

1 32. The apparatus of claim 31 wherein said subset of  
2 said set of parameters is said set of parameters.

1 33. The apparatus of claim 31, wherein said one or more  
2 computer programs also for:  
3 supplying, by a data acquisition module, said  
4 training data.

1 34. The apparatus of claim 31 wherein said training data  
2 comprises archived data.

1 35. The apparatus of claim 31 wherein said training data  
2 comprises simulated nominal data.



1     36. The apparatus of claim 31 wherein said training data  
2     comprises off-nominal data.

1     37. The apparatus of claim 31, wherein said one or more  
2     computer programs also for:  
3         scaling said training data with at least one  
4     parameter of said set of parameters.

1     38. The apparatus of claim 31 wherein said generating  
2     comprises:  
3         determining a distance between one of said vectors  
4     and one of said clusters, and  
5         producing a new cluster if said distance exceeds a  
6     threshold value.

1     39. The apparatus of claim 31 wherein said generating  
2     comprises:  
3         determining a distance between one of said vectors  
4     and one of said clusters, and  
5         expanding said one of said clusters to include said  
6     vector when said distance is less than or equal to a  
7     threshold value.

1     40. The apparatus of claim 31, wherein said one or more  
2     computer programs, executed by said computer, further  
3     comprises, for:  
4         indexing said clusters of said cluster database  
5     based on a distance of each of said clusters from a  
6     predetermined indexing reference point.

1     41. An apparatus for monitoring a system, comprising:  
2         a computer having a memory storing a cluster  
3         database comprising clusters, said clusters being  
4         associated with respective ranges of values for at least  
5         a subset of a set of cluster parameters; and  
6         one or more computer programs, executed by said  
7         computer, for:  
8         receiving one or more monitored-system vectors  
9         having monitored-system parameters; and  
10        determining whether said monitored-system vector is  
11        contained in one of said clusters based on at least a  
12        subset of said monitored-system parameters and said at  
13        least a subset of said cluster parameters.

1     42. The apparatus of claim 41, said determining also for,  
2     if one of said monitored-system vectors is not contained  
3     in one of said clusters, said determining determines a  
4     distance of said one monitored-system vector from the  
5     nearest of said clusters, wherein said distance is  
6     associated with a severity of a deviation.

1     43. The apparatus of claim 42 wherein said determined  
2     distance provides a comparison result for each monitored-  
3     system vector, said one or more computer programs further  
4     comprising:  
5         supplying the monitored-system vectors and their  
6         associated comparison result to another learning  
7         application.

1     44. The apparatus of claim 41, said one or more computer  
2     programs also for examining said monitored-system  
3     vectors, and, if any parameter of one of said monitored-  
4     system vectors is erroneous, said examination adjusts  
5     said erroneous parameter such that said parameter will  
6     match any range specified for said parameter in any  
7     cluster of said cluster database.

1     45. The apparatus of claim 41, wherein said memory also  
2     stores an additional cluster database, the clusters of  
3     said additional cluster database being associated with  
4     respective ranges of values for at least a subset of said  
5     set of parameters, said additional cluster database being  
6     annotated with diagnostic information; and

7         wherein, if one of said monitored-system vectors is  
8     not included in one of said clusters, said determining  
9     compares said one of said monitored-system vectors with  
10    said clusters of said additional cluster database.